

THE WEATHER AND CIRCULATION OF DECEMBER 1963

An Unusually Cold Month

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1. WEATHER EXTREMES

"Coldest December on record" was a frequent comment in climatological reports from many cities in the Middle and Lower Mississippi Valley, the Ohio Valley, and parts of the Gulf Coast States. Listed in table 1 are cities where new records were established for length of cold. Not a record, but an example of extreme cold occurred at Moline, Ill.; here during a 6-day period at mid-month the temperature averaged 33° F. lower than normal.

Snowfall in record amounts was reported in numerous cities in the Central States and the South (table 2). The principal track of Lows was in the vicinity of the Great Lakes (see Chart IX of [1]) where there was abundant snowfall. However, most of the records were in southern cities and primarily a result of one storm on the last day of December. It is noteworthy that three cities (Erie, Pa., Meridian, Miss., and Muskegon, Mich.) received more snow this month than in any month of record. A record not included in table 2 was established at Mobile, Ala. This was the first December since records began (1872) during which snow covered the ground.

2. MONTHLY MEAN CIRCULATION

GENERAL FEATURES

Marked amplification of long waves over most of the Northern Hemisphere this month (fig. 1) characterized the mean 700-mb. circulation in December 1963. This relatively low index state is also pictured in figure 2, the height anomaly for December. In this chart the strong meridional nature of the anomalous flow is apparent over the eastern Pacific and North America. Low index conditions in the Atlantic were related to a blocking complex in which height anomalies were positive in the north and negative in the south.

Differences between the 700-mb. flow in the Atlantic and Pacific can be further distinguished. Figure 3 shows the mean 700-mb. isotachs during December and average positions of the principal jet axes. In the Atlantic the westerlies split into two branches south of Newfoundland. The influence of blocking is thus manifest with the principal band of westerlies displaced over North Africa and a secondary stream (normally near Iceland) extending

northward across Greenland and Scandinavia to meet the principal jet again in western Siberia.

Now note the path of the average maximum wind in the eastern Pacific. Here there was no split in the westerlies, but a long, meridional fetch from middle latitudes almost to the North Pole. This jet essentially is continued by the one arising in northern British Columbia. There is little suggestion of a maximum wind current breaking into the Pacific Northwest as occurs normally.

TABLE 1.—Records for duration of cold in December established in 1963

Location	Duration of cold (days)	
	Minimum temperature	
	6° F. or lower	32° F. or lower
Dayton, Ohio.....	8	
Des Moines, Iowa.....	*11	
Fort Wayne, Ind.....	10	
Indianapolis, Ind.....	11	
Rockford, Ill.....	*11	
Springfield, Ill.....	12	
St. Louis, Mo.....	7	
Atlanta, Ga.....		25
Boston, Mass.....		19
Cincinnati, Ohio.....		20
Concord, N.H.....		23
Rome, Ga.....		28

*Consecutive days.

TABLE 2.—Snowfall records established in December 1963

Type of record	Location	Amount (in.)
24-hour.....	Birmingham, Ala.....	8.0
	Little Rock, Ark.....	9.8
	Meridian, Miss.....	15.0
	Muskegon, Mich.....	24.1
	Nashville, Tenn.....	7.4
December.....	Birmingham, Ala.....	8.0
	Bristol, Tenn.....	12.9
	Erie, Pa.....	56.0
	Little Rock, Ark.....	9.8
	Meridian, Miss.....	17.6
	Muskegon, Mich.....	82.6
	Nantucket, Mass.....	24.7
	Nashville, Tenn.....	13.2
	Sault Ste. Marie, Mich.....	41.3
	Texarkana, Ark.....	5.3
Any month.....	Erie, Pa.....	56.0
	Meridian, Miss.....	17.6
	Muskegon, Mich.....	82.6

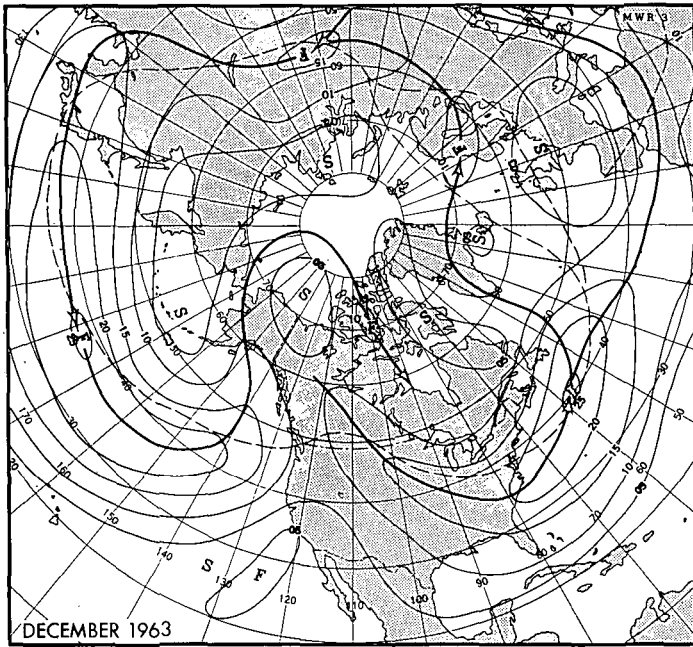


FIGURE 3.—Mean 700-mb. isotachs (meters per second) for December 1963. Solid arrows indicate principal axes of maximum wind speed and dashed lines the normal December positions. Some effects of blocking are illustrated with the principal jet south of normal from eastern United States to Europe and a secondary jet to the north.

In Asia the circulation was featured by an intense polar vortex near 80° N. This large Low, some 470 ft. deeper than normal, was basically responsible for the strong zonal flow at high latitudes.

A NEW CIRCULATION REGIME

Fall 1963 was unseasonably warm over most of the United States with only a portion of the Southeast slightly cooler than normal. Flow at the 700-mb. level was predominantly zonal and generally anticyclonic with a deep trough off the west coast and a weak trough off the east coast. During this time the temperate latitude westerlies were somewhat stronger than normal in the western portion of the Northern Hemisphere. But with the onset of the winter season in December, widespread changes in the circulation occurred during which the zonal index averaged 1.8 m.p.s. lower than normal.

Differences between the circulation in November and December are pictured in figure 4, the height anomaly change between the two months. Large negative changes in the central Pacific reflect the retrogression of the trough formerly in the Gulf of Alaska (fig. 1 of [2]). This trough in December did not deepen simultaneously with or prior to growth of the ridge over western North America. It is clearly evident from overlapping 5-day mean charts that the trough deepened subsequent to strengthening of the ridge. Negative height anomaly changes in the eastern half of North America indicate general deepening and some decrease in blocking near Baffin Island.

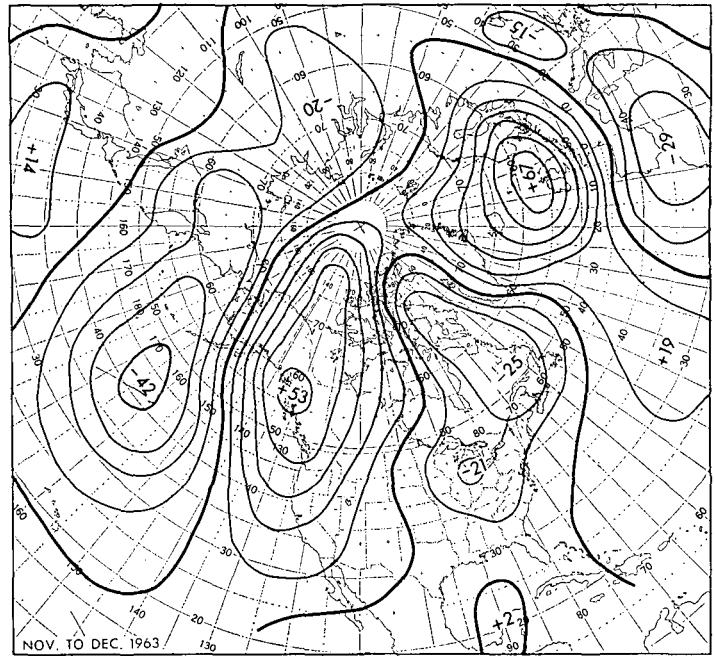


FIGURE 4.—Change in mean 700-mb. height anomaly (tens of feet) from November to December 1963. Cellular changes illustrate the marked shift from zonal flow in November to meridional flow in December.

Important height anomaly changes in the Atlantic are those associated with blocking. A strong ridge (figs. 1 and 2) from the North Sea to Greenland replaced the Low that was located there in November. A major result of these changes was a split in the westerly flow, discussed earlier. The southward displacement of the principal belt of westerlies was accompanied by average 700-mb. wind speeds as much as 10 m.p.s. faster than normal in the trough near Spain.

It is apparent that blocking in the Atlantic contributed to the circulation that affected the United States, but it is difficult to assess its precise role. It appears that a blocking wave spread westward from Iceland this month and reinforced the ridge in western North America (see sec. 4). This almost concurrent decrease in blocking in one area and its transfer upstream has been observed for many years. However, considering only the monthly mean 700-mb. height anomaly chart (fig. 2), the strong ridge in western North America and blocking in the Atlantic seem to be only loosely associated.

Another diagnostic aspect of the 700-mb. circulation in December was a major index cycle (fig. 5). It was exceptional because of its occurrence this month instead of during the late winter and early spring [3]. As indicated earlier the index had been averaging above normal and as the index cycle began, late in November, the 5-day mean value was 3.6 m.p.s. faster than normal. The index dropped steadily until by mid-December it was 3.6 m.p.s. slower than normal as cold air from higher latitudes dis-

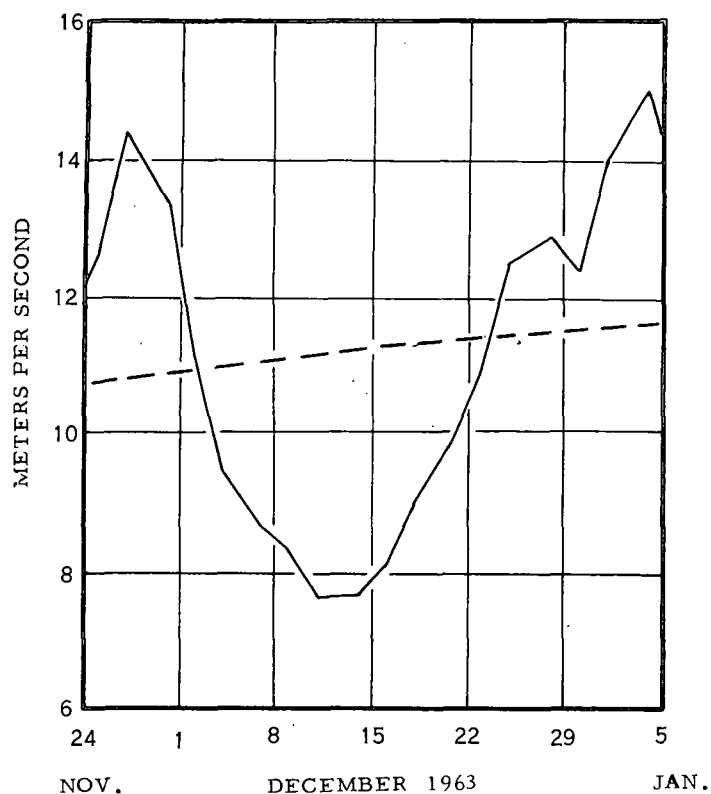


FIGURE 5.—Time-variation of 700-mb. zonal index (35°–55° N. and 5° W.–175° E.) (solid) and normal (dashed) for December 1963. Indices were derived from overlapping 5-day mean charts computed three times per week and plotted at end of each period.

placed warm air in lower latitudes, and vice versa. The recovery phase of the cycle began soon thereafter and reached high values early in January, coincident with the decrease of blocking in the Atlantic (see sec. 4).

3. AVERAGE MONTHLY WEATHER TEMPERATURE

Repeated surges of Arctic air after the first week in December precluded even temporary moderation of the cold. Further support of continued cold was furnished by an abnormal snowcover that reached into the Gulf Coast States at times. Figure 6, the departure of average temperature from normal for December, is reminiscent of January 1963 [4], the historically cold month during which low temperatures also extended from coast to coast. This was the coldest December on record in more than 40 major cities in 18 states from Iowa to Ohio and southward to the Gulf Coast States. According to early reports there were also a few records broken in Maine, Vermont, and Massachusetts. Other temperature records set this month include duration of cold, table 1, and new December minima at Shreveport, La. (8.8° F.), and Little Rock, Ark. (–1° F.).

Temperatures in the West were generally below normal despite above normal heights and a ridge. The cold area from Utah to southwestern Montana was probably main-

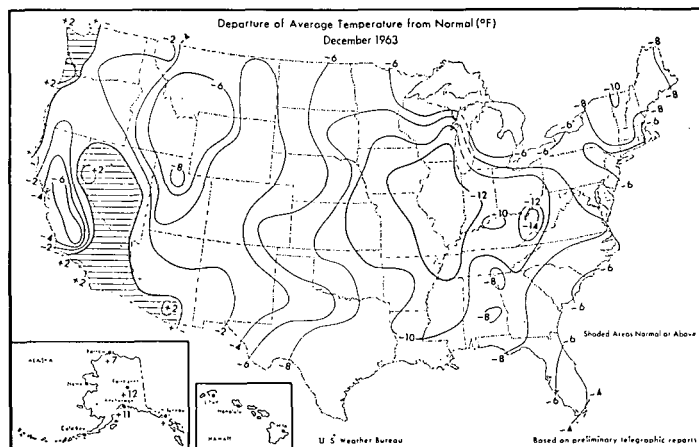


FIGURE 6.—Departure of average surface temperature from normal (°F.) for December 1963. It is unusual for temperatures to average so much lower than normal over such a large area. (From [6].)

tained by a combination of factors such as cold air that spilled across the Divide, snowcover that was prevalent in December, and nocturnal radiation. In the San Joaquin and Sacramento Valleys of California cold was principally a function of persistent fog and low cloudiness. At Fresno, December was the second foggiest month on record with 22 such days; Sacramento had 26 cloudy days, also a record for the month.

In contrast to the cold there was also some warmth in portions of the West, but temperatures were only a degree or two above normal. Record maximum temperatures were reported in California at San Diego (88° F.) and at Eureka (77° F.).

Month-to-month persistence of temperature anomalies was large from October to November and extremely small from November to December. Such abrupt changes in regime from November to December are uncommon; they occur most frequently from May to June [5] with a secondary maximum from October to November. Of 100 representative stations across the Nation, only 10 remained in the same temperature anomaly class (out of five) or changed by no more than one class. The distribution of temperature anomaly change by class, shown in table 3,

TABLE 3.—Class changes of monthly average surface temperature anomalies in 100 cities from November to December 1963

Class change*	Frequency (percent)
+4	0
+3	0
+2	0
+1	1
0	2
-1	7
-2	26
-3	40
-4	24

*+ indicates a change toward higher average temperature, toward lower. Classes are much below, below, normal, above, and much above.

reveals some interesting details. Only one city warmed by one anomaly class and two were unchanged; the other 97 cities cooled by one to four classes. It is also notable that 64 percent of the stations experienced three- or four-class changes. In the study cited above it was found that the average persistence of temperature anomalies from November to December was 67 percent and chance was about 59 percent.

PRECIPITATION

Over the Northern Plains and westward, precipitation totals were about normal (fig. 7), while the Southeast received generally heavy amounts. Elsewhere, from the Southwest across the Plains to New England, relatively dry conditions prevailed. Continued deficiencies this month sustained drought conditions, especially in Ohio. Here, by the end of December, soil moisture was far below normal with Cleveland reporting its annual (1963) precipitation as 18.63 in., the driest year since records began in 1871. Akron received 65 percent of normal precipitation and this was their driest year of record. Other cities reported record dryness for December including Detroit, Mich., Louisville, Ky., Caribou, Maine, and Dallas, Tex.

Snowfall was quite heavy and rather general this month in the eastern third of the Nation. Many records for 24-hr. snowfall and December total snowfall were established from the Lakes to the Gulf States (table 2). Referring to figures 1 and 2, the monthly mean 700-mb. flow, it is seen that the heavy snow fell along and to the rear of the mean trough where the contours were broadly cyclonic and heights were well below normal. Except for one storm early in the month, perturbations that traversed the Lakes area were relatively weak (see chart IX of [1]). However, short waves aloft associated with the surface activity were sufficiently vigorous to produce generous snows. Storms that originated in the Gulf of Mexico released snow in the South and along the east coast, accompanied by near-blizzard conditions.

4. WEEKLY VARIABILITY

WEEK ENDING DECEMBER 8

Some retrogression and flattening of the 7-day mean 700-mb. flow (figs. 8A and 8B) occurred this week as a blocking ridge spread to Iceland from its former location over north central Europe. Despite temporary weakening of the ridge over western North America, cold air was driven into the Gulf of Mexico and throughout the East Coast States (fig. 8C). Most of the West cooled several degrees this week, influenced by much fogginess and persistent radiation associated with continuous high pressure.

Early in the week a small storm moved from the Northern Plains and out through the Ohio Valley, and was followed by quite cold air that lowered temperatures from New York State (0° F.) to Florida (28° F. at Tallahassee). Some heavy snow fell in the Ohio Valley and New England as this storm passed.

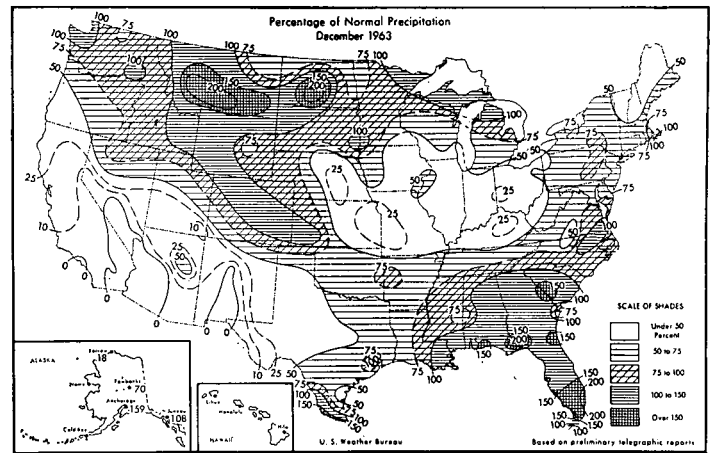


FIGURE 7.—Percentage of normal precipitation for December 1963. Despite heavy snowfall precipitation was less than normal over much of the Central States area. (From [6].)

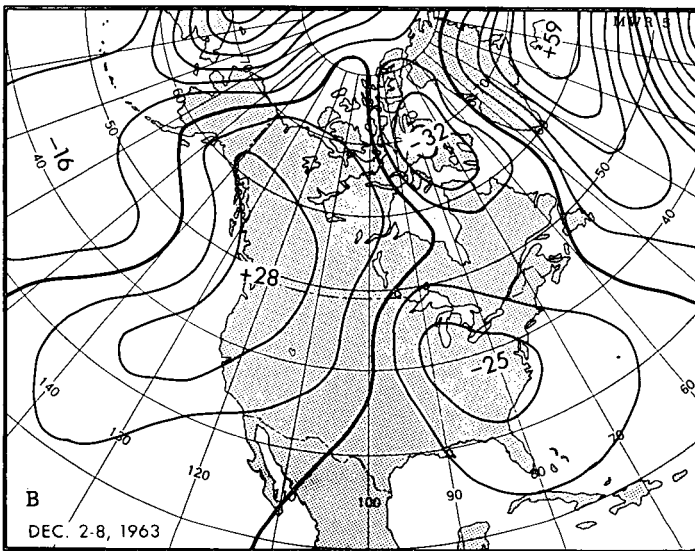
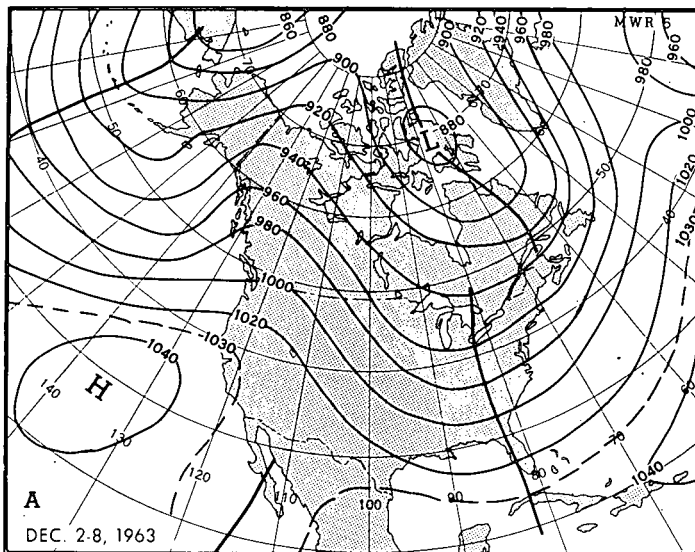
Near the end of the week, winds aloft became westerly across the northwestern quarter of the country. Foehn warming was immediate with temperatures rising temporarily to the high 50's and low 60's from Montana to Texas. In the westerly flow a new Low from the Pacific deepened after crossing the Rockies and became the worst storm of the month in the Plains where blizzard conditions were prevalent (75 m.p.h. gusts reported in Iowa, Nebraska, and Kansas).

WEEK ENDING DECEMBER 15

Over western North America the ridge amplified and retrograded somewhat as slight deepening occurred in the central Pacific trough (figs. 9A and 9B). Meanwhile heights increased near Iceland and across Canada to the eastern Pacific where values were 630 ft. higher than normal off the British Columbia coast. South of the strong blocking across Canada, anomalous heights were negative over most of the United States. This circulation favored the southward transport of very cold air. Thus temperatures for the week averaged below normal over the entire United States (fig. 9C).

Many places from Kansas to North Dakota had averages that were 20°–25° F. below normal. Lowest weekly average temperature was –4° F. at Bismarck, N. Dak. Temperatures to 0° F. reached the Texas Panhandle, while freezing weather extended to the Gulf of Mexico and into northern Florida.

Snow showers were frequent in the Lakes area and eastward the first few days this week. Then a Nevada-type Low spread snow and rain over most of the West. After this storm passed the Rockies, heavy snow fell across the northern portions and rain, with some freezing rain, fell from the Ohio Valley to the Gulf Coast. Portions of the Gulf Coast States received 3–4 in. of precipitation.



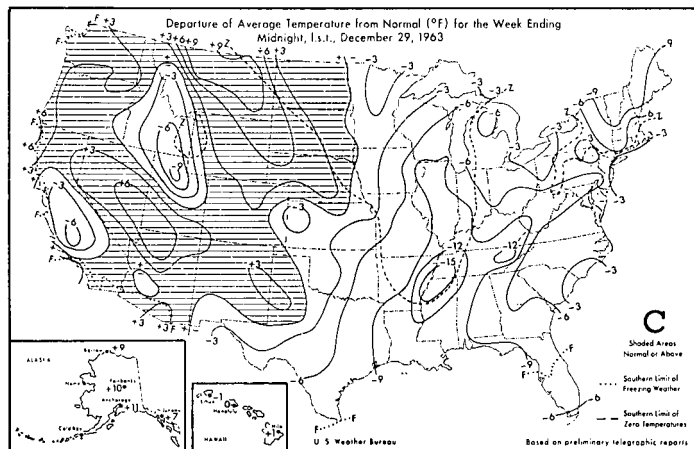
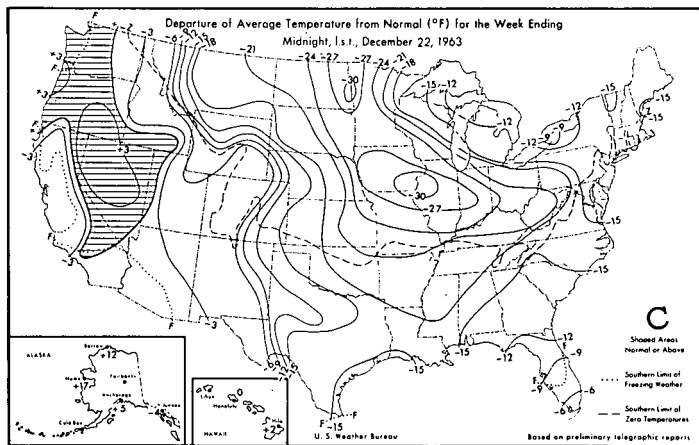
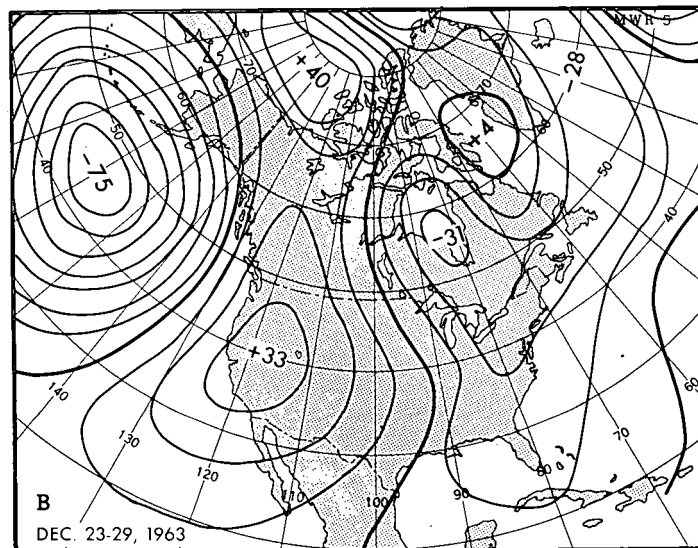
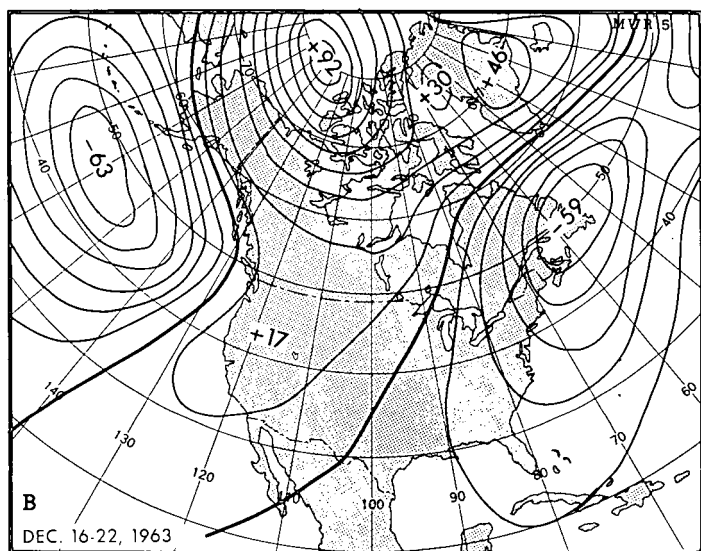
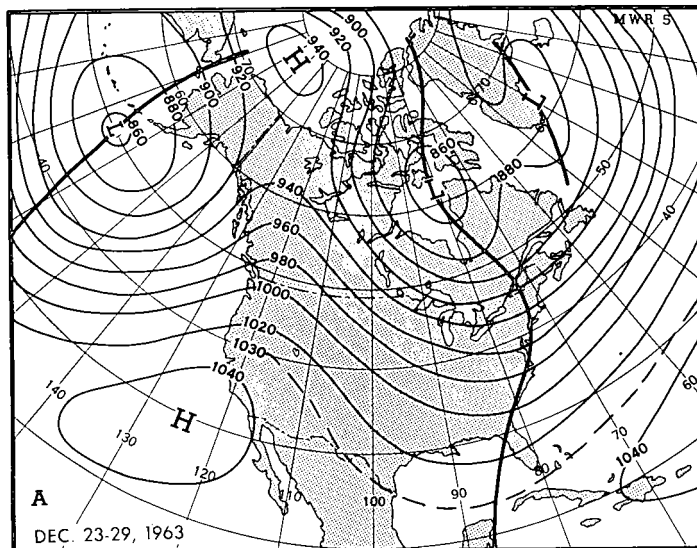
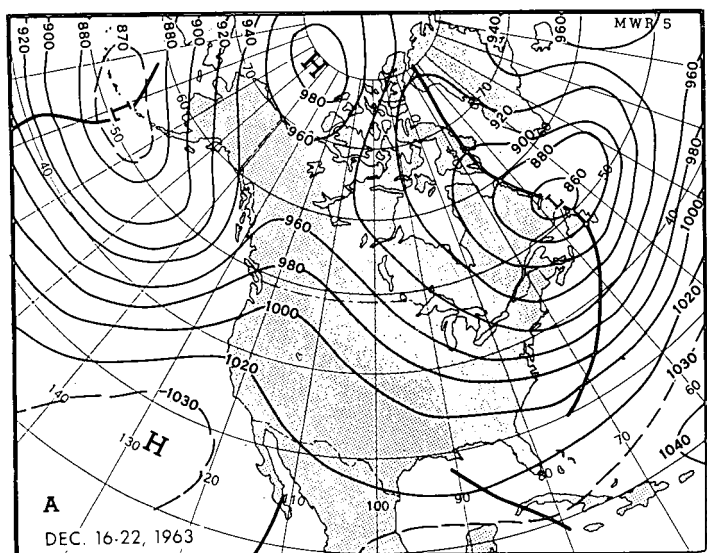


FIGURE 10.—(A) Mean 700-mb. contours (tens of feet); (B) mean 700-mb. height departures from normal (tens of feet); and (C) departure of average surface temperature from normal (°F.) (from [6]), all for week ending December 22, 1963. Coldest week of the month east of the Continental Divide occurred as the zonal index (fig. 5) was rising.

FIGURE 11.—(A) Mean 700-mb. contours (tens of feet); (B) mean 700-mb. height departures from normal (tens of feet); and (C) departure of average surface temperature from normal (°F.) (from [6]), all for week ending December 29, 1963. Warming in the West occurred as the ridge in middle latitudes intensified. Northerly anomalous flow helped maintain cold in the eastern half of the Nation.

WEEK ENDING DECEMBER 11

This week was dominated by the most severe cold waves of the month. Blocking decreased in the Icelandic area (figs. 10A and 10B) and apparently reappeared over the Beaufort Sea. Here the height anomaly associated with the High at 700 mb. was 920 ft. greater than normal. Deepening of the trough in eastern North America reinforced the northwesterly flow that transported three Arctic air masses into the country east of the Divide.

Temperatures for the week were lower than normal (fig. 10C) except in portions of the Great Basin and Pacific Northwest. It was unusually cold east of the Continental Divide with the freezing line reaching to the Gulf of Mexico and well into central Florida. Temperatures of 0° F. or lower were noted as far south as northern Tennessee, southern Missouri, and northern Oklahoma. Temperatures averaged 20°–30° F. below normal from the northern Plains to the Ohio Valley. Average temperatures for the week at Moline, Ill., and Omaha, Nebr., were –4° F., or 31° F. below normal. International Falls, Minn., coldest in the Nation, averaged –15° F. while Fargo, N. Dak., had the largest temperature anomaly (–32° F.).

Rather heavy snow fell the first three days of the week from the northern Rockies to the east coast, associated with a perturbation on the Arctic front. This storm preceded the second Arctic High of the week and deepened remarkably in the vicinity of Nova Scotia as it moved into the mean trough. Sea level pressure in the Low decreased from 1005 mb. off New Jersey to 952 mb. over the Gulf of St. Lawrence in a 24-hr. period.

Precipitation in the last three days consisted of heavy rains in the Pacific Northwest, snow along the eastern slopes of the Rockies and into the Plains, and an inch of rain along the central Gulf Coast and in southern Florida.

WEEK ENDING DECEMBER 29

Deepening of the Pacific trough continued for the fourth week this month (figs. 11A and 11B), and blocking in high latitudes weakened considerably. The ridge over western United States was dominant, with heights some

300 ft. higher than normal in the Great Basin. The Low formerly over Labrador migrated northward and split into two cells.

Appreciable warming occurred this week in most areas (fig. 11C). However, the eastern half of the Nation remained cold with temperatures 6°–9° F. below normal in the Gulf States. The lowest temperature was –17° F. at Memphis, Tenn. Temperatures in the West increased, excluding the San Joaquin Valley and portions of Utah and Idaho. Largest positive temperature anomaly, +12° F., was reported at Great Falls, Mont.

Storminess diminished this week. Consequently, there was little precipitation over most of the United States but there were heavy rains along the northern Pacific Coast and in portions of the East Coast States. Two waves from the Gulf of Mexico, one early in the week, produced rain in the South and spread snow to the Lakes. On the last day of the month another wave deepened and deposited heavy snow in parts of the South and Southeast and a severe, damaging glaze in Georgia. Especially heavy snow was reported at Meridian, Miss. (14 in.), Huntsville, Ala. (16 in.), Birmingham, Ala. (8 in.), Augusta, Ga. (6.6 in.), and Nashville, Tenn. (5.8 in.).

REFERENCES

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